

Treatment Outcomes in Patients Undergoing Surgical Treatment for Arthritis of the Distal Radioulnar Joint

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Abstract

Objective Surgical treatment options for distal radioulnar joint (DRUJ) arthritis include distal ulnar resection (DUR), DRUJ arthrodesis, and ulnar head replacement. Ulnar convergence leading to persistent pain and clicking is a relatively common complication of complete DUR and DRUJ arthrodesis with distal ulnar segment resection (DRUJA). This led to the development of the distal ulna hemiresection (DUHR) and distal ulnar stump stabilization techniques to reduce the risk of this complication. Patients may experience incomplete relief of pain and limited range of motion (ROM) with these procedures. We hypothesized that there would be no differences in outcomes between the treatment groups, but patients undergoing DUHR, tendon interposition, or distal ulnar stump stabilization would be at lower risk of complications.

Methods Records were retrospectively reviewed for 121 patients undergoing DRUJ procedures between 2000 and 2018 at a single institution to collect patient demographics, surgical details, preoperative diagnosis, and outcomes including complications, revision procedures, ROM, pain, and swelling. Patients were grouped for analysis by procedure type: DUR (Darrach procedure), DUHR (Bowers procedure), and DRUJA (Sauve–Kapandji procedure). Continuous variables were compared using an analysis of variance test and categorical variables using the Freeman–Halton extension of the Fisher's exact test. A multivariate logistic regression analysis was performed to identify significant predictors of outcomes.

Results Seventy-three patients underwent a DUR procedure, while 33 patients underwent a DUHR procedure and 11 underwent a DRUJA procedure. Mean follow-up was 70.6 months. Patients undergoing DRUJA were significantly younger than those undergoing DUR or DUHR procedure (42.4 vs. 60.0 vs. 62.1, $p < 0.001$). No significant differences between groups were demonstrated in measured outcomes. Posttraumatic arthritis was the most common preoperative diagnosis (43.4%). Persistent pain was the most common negative outcome (25.6%) followed by limited ROM (19.7%). Five patients (4.3%) suffered postoperative complications, most common being rupture of extensor tendons. Five patients (4.3%) underwent revision procedures. Body mass index (BMI) was a significant predictor of persistent pain (odds ratio = 1.09, $p = 0.031$).

Keywords

- ▶ distal radioulnar joint
- ▶ DRUJ trauma
- ▶ Suave–Kapandji
- ▶ Darrach
- ▶ Bowers

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Conclusion The results of our study suggest that outcomes are equivalent between the three distinct treatment groups. Despite the potential benefits, hemiresection, tendon interposition, and distal stump stabilization had no significant effect on outcomes in this study. More than a quarter (25.6%) of patients undergoing DRUJ procedures experience persistent pain postoperatively, while one-fifth (19.7%) experienced limited ROM. Patients with higher BMI are at a significantly greater risk of experiencing persistent postoperative pain.

Level of Evidence This is a Level III, retrospective comparative study.

The distal radioulnar joint (DRUJ), along with the proximal radial-ulnar joint, facilitate rotation of the forearm. There is limited congruency between the articular surfaces of the radius and ulna, so while stability of the DRUJ relies heavily on the surrounding static and dynamic soft tissue stabilizers. Disruption of these stabilizers, commonly observed with distal radial fractures, can lead to instability of this joint and subsequent arthritis. Inflammatory arthritis, congenital deformities, and degenerative joint disease can also lead to degenerative changes of this joint, resulting in pain, crepitus, and limited range of motion (ROM) with pronation and supination of the forearm.¹

Complete resection of the distal ulna (DUR), often referred to as the Darrach procedure, is a longstanding treatment of DUR arthritis. While some studies have shown that this procedure provides favorable long-term outcomes in terms of pain relief and function,^{2–4} others have revealed that this procedure can result in convergence of the distal ulna upon the radius, potentially leading to painful clicking with forearm rotation and weak grip.^{5–7} As a result of these shortcomings, DUR is generally recommended for older individuals with low functional demands.⁶ Several other procedures, including partial distal ulna hemiresections (DUHR; Bowers procedure), arthrodesis of the DRUJ in combination with segmental ulnar resection (DRUJA; Suave–Kapandji procedure), and distal ulna implant arthroplasty have been utilized to address the limitations of the DUR.^{8–18}

There is a paucity of data in the existing literature comparatively evaluating the outcomes of these surgical procedures. In this study, we aimed to determine whether there is a difference in outcomes between the types of procedures commonly performed for DRUJ arthritis. We hypothesized that there would be no differences in outcomes between the treatment groups, but patients undergoing DUHR, tendon interposition, or distal ulnar stump stabilization would be at lower risk of complications.

Methods

After institutional board review approval, the surgical database of a regional orthopaedic surgical group was queried to identify all patients undergoing DRUJ procedures. Between 2000 and 2018, patients billed for Current Procedural Terminology codes 25240 (excision distal ulna partial or complete [e.g., DUR or DUHR]), 25830 (arthrodesis, distal radioulnar joint with seg-

mental resection of ulna, with or without bone graft [e.g., DRUJA]), and 25442 (arthroplasty with prosthetic replacement distal ulna) were identified. Patients were grouped by procedure type: DUR procedure, DUHR procedure, DRUJA procedure, or ulnar head replacement.

Records were reviewed to collect patient demographics including age, gender, race, and body mass index (BMI). Additional data collected included surgical indications, additional preoperative diagnoses, procedural details, 90-day postoperative complications, revision procedures, and physical exam findings, including ROM and pain.

Surgical indications were grouped into rheumatoid arthritis, primary osteoarthritis (OA), and posttraumatic arthritis, including patients with prior distal radius fractures. Any additional preoperative diagnoses were recorded when present for each patient, including DRUJ instability, extensor carpi ulnaris (ECU) tenosynovitis, triangular fibrocartilage complex (TFCC) tear, and ulnocarpal abutment. In addition to recording primary surgeries, operative reports were reviewed to determine whether any concomitant procedures were performed, such as TFCC debridement, ECU tenosynovectomy, or distal ulnar stump stabilization.

Continuous variables were analyzed using an analysis of variance test, while categorical variables were compared utilizing the Freeman–Halton extension of Fisher's exact test since all variables included expected or observed counts of five or less. A multivariate logistic regression analysis was performed to identify independent significant risk factors for complications or adverse outcomes. Statistical significance was set at a *p*-value of 0.05.

Results

Our database query identified 121 DRUJ procedures performed on 121 patients by 12 board-certified hand surgeons at a single institution. Given that only four patients underwent ulnar head replacement, this group was removed from analysis. Of the 117 patients included in the study cohort, 73 (62%) underwent DUR, 33 (28%) underwent DUHR, and the remaining 11 patients (9%) underwent a DRUJA. The patients had a mean age of 59.7 years (standard deviation [SD] = 14.3), were 65.0% female, 79.5% white, and had an average BMI of 28.6 kg/m² (SD = 6.2) (► **Table 1**). Patients undergoing DRUJA procedure were significantly younger than either the DUR or DUHR procedure groups (42.4 vs. 60.0 vs. 62.1 years, *p* = 0.001), otherwise no

Table 1 Demographics of patients undergoing DRUJ surgery

Demographics	Distal ulna resection (Darrach procedure) (N = 73)	DRUJ arthrodesis (Suave–Kapandji procedure) (N = 11)	Distal ulna hemiresection (Bowers procedure) (N = 33)	Total (N = 117)	Significance
Age	59.97 (14.12)	42.38 (11.48)	62.12 (10.29)	59.65 (14.25)	< 0.001 ^a
Gender					0.084 ^b
Male	28 (38.4)	6 (54.5)	7 (21.2)	41 (35.0)	
Female	45 (61.6)	5 (45.5)	26 (78.8)	76 (65.0)	
Ethnicity					0.636 ^b
White	57 (78.1)	8 (72.7)	28 (84.8)	93 (79.5)	
Black	8 (11.0)	0 (0.0)	3 (9.1)	11 (9.4)	
Other	2 (2.7)	1 (9.1)	2 (6.1)	5 (4.3)	
Unknown	6 (8.2)	1 (9.1)	0 (0.0)	7 (5.9)	
BMI	28.70 (6.33)	25.79 (2.73)	30.23 (7.15)	28.55 (6.16)	0.289 ^a

Abbreviations: ANOVA, analysis of variance; BMI, body mass index; DRUJ, distal radioulnar joint; SD, standard deviation.

Note: Reported as mean (SD) or *n* (%). Statistically significant values are emboldened.

^aANOVA.

^bPearson's chi-square analysis.

differences in patient demographics, including gender, BMI, or ethnicity, were observed between treatment groups.

Posttraumatic arthritis was the most common indication for surgery (44%), followed by OA (38%) and inflammatory arthritis (15%) (► **Table 2**). Tears in the TFCC were observed in 36 patients (29%), which were documented in magnetic resonance imaging reports of 19 patients and in operative reports of 30 patients. Patients who underwent DUHR procedures had significantly more ECU tenosynectomies performed alongside their primary procedure than those who received DUR or DRUJA procedures (► **Table 3**). Other procedures that were commonly performed alongside DRUJ procedures included TFCC debridement, documented in 32 operative reports (28%), and distal ulnar stump stabilization, documented in 33 operative reports (29%).

The most common postoperative outcomes across all three treatments were limited ROM occurring in 19.7% (9.1–25.4%) and persistent pain in 25.6% (18.2–32.2%) of all patients (► **Table 4**). Persistent swelling was the third most common adverse postoperative outcome, occurring in 4.3%

of patients. In addition to these findings at follow-up, five additional postoperative complications (4.3%) were observed, three involved rupture of extensor tendons. Rupture of the extensor pollicis longus tendon occurred in a patient with posttraumatic arthritis following DUR with ECU stabilization, rupture of the extensor digitorum communis (EDC) of the middle, ring, and small finger occurred in a patient with OA following DUR with proximal stump stabilization, and rupture of the EDC of the little finger occurred in a patient with OA following DUHR. Postoperative instability was not appreciated in any of the patients with extensor tendon ruptures. There were no significant differences in postoperative outcomes between treatment groups, nor were there significant differences in the rates of complications or revision procedures between groups (► **Table 4**).

Multivariate regression identified BMI as a significant predictor of persistent pain postoperatively (odds ratio 1.09, 95% confidence interval 1.01–1.17, *p* = 0.031). No other statistically significant predictors of outcomes were identified (► **Table 5**).

Table 2 Surgical indications for DRUJ surgery

Preoperative diagnosis	Distal ulna resection (Darrach procedure) (N = 73)	DRUJ arthrodesis (Suave–Kapandji procedure) (N = 11)	Distal ulna hemiresection (Bowers procedure) (N = 33)	Total (N = 117)	Significance
Inflammatory arthritis	13 (18.1)	1 (9.1)	4 (12.5)	18 (15.4)	0.730 ^a
Primary osteoarthritis	26 (35.6)	3 (27.3)	15 (45.5)	44 (37.6)	0.516 ^a
Posttraumatic arthritis	33 (45.8)	6 (54.5)	12 (36.4)	51 (43.6)	0.476 ^b
Prior fracture	18 (25.4)	4 (36.4)	6 (18.8)	28 (23.9)	0.428 ^a

Abbreviation: DRUJ, distal radioulnar joint.

Note: Reported as *n* (%). Statistically significant values are emboldened.

^aFisher–Freeman–Halton exact test.

^bPearson's chi-square analysis.

Table 3 Concomitant procedures performed alongside primary DRUJ surgeries

Procedure	Distal ulna resection (Darrach procedure) (N = 73)	DRUJ arthrodesis (Suave–Kapandji procedure) (N = 11)	Distal ulna hemiresection (Bowers procedure) (N = 33)	Total (N = 117)	Significance ^a
TFCC debridement	23 (32.4)	1 (9.1)	8 (24.2)	32 (27.3)	0.286
ECU tenosynovectomy	25 (35.2)	3 (27.3)	21 (63.6)	49 (41.9)	0.010
Distal stump stabilization	28 (39.4)	5 (45.5)	0 (0.0)	33 (28.2)	0.000

Abbreviations: DRUJ, distal radioulnar joint; ECU, extensor carpi ulnaris; TFCC, triangular fibrocartilage complex.

Note: Reported as n (%). Statistically significant values are emboldened.

^aFisher–Freeman–Halton exact test.

Table 4 Negative postoperative outcomes associated with DRUJ surgery

Outcomes	Distal ulna resection (Darrach procedure) (N = 73)	DRUJ arthrodesis (Suave–Kapandji procedure) (N = 11)	Distal ulna hemiresection (Bowers procedure) (N = 33)	Total (N = 117)	Significance ^a
Limited range of motion	18 (25.35)	1 (9.1)	4 (12.1)	23 (19.7)	0.285
Persistent pain	17 (23.9)	2 (18.2)	11 (32.2)	30 (25.6)	0.523
Persistent swelling	4 (5.6)	0 (0.0)	1 (3.0)	5 (4.3)	1.000
Complications	3 (4.3)	1 (9.1)	1 (3.0)	5 (4.3)	0.590
Revisions	4 (5.5)	1 (9.1)	0 (0.0)	5 (4.3)	0.189

Abbreviation: DRUJ, distal radioulnar joint.

Note: Reported as n (%). Statistically significant values are emboldened.

^aFisher–Freeman–Halton exact test.

Table 5 Significant predictors of outcomes

Outcome	Predictor	Odds ratio	95% Confidence interval	Significance ^a
Postoperative complication	No significant predictors identified		–	–
Persistent pain	BMI	1.09	(1.01, 1.17)	0.031
Limited ROM	No significant predictors identified		–	–
Revision procedure	No significant predictors identified		–	–

Abbreviations: BMI, body mass index; ROM, range of motion.

Note: Statistically significant values are emboldened.

^aBackward elimination multivariate logistic regression analysis.

Discussion

DRUJ arthritis is relatively common, affecting up to 11% of patients who suffer from distal radius fractures, which can often become a debilitating source of pain and limited function for patients.^{1,8} When conservative measures for management are unsuccessful, surgical treatment may be indicated. Multiple procedures have been described for treatment of patients with DRUJ arthritis, all showing relative success in relieving pain, but each with common complications that leave room for improvement with such techniques. Currently, there exists little evidence comparing long-term outcomes of the common DRUJ procedures and if techniques designed to prevent complications, such as DUHR, distal stump stabilization, or tendon interposition, are effective in improving outcomes.

Within our study, patients undergoing each of the procedure types were comparable, aside from age and incidence of ECU tenosynovitis. While functional demands were not specifically assessed in this study, one could surmise that younger patients likely have higher functional demands which theoretically place greater stress on the wrist. Given that arthrodesis of the DRUJ provides greater stability to the wrist,⁹ it may be the preferred option among surgeons for treating younger patients with higher demands and explain the age difference observed with this procedure.

Among the outcomes assessed in this study, we were unable to detect differences between procedures and no procedural details were identified as significant predictors of outcomes. However, a substantial portion of patients had continued pain and limited ROM following their procedure. It

may be that despite the changes in surgical technique that have developed to reduce complications, no difference exists between procedures, or true differences may exist, but they were unable to be detected within our study.

Several procedures have been introduced at least in part to address the limitations of DUR. DUHR, known as Bowers procedure, allows for the preservation of the soft tissue stabilizers around the distal radial ulnar joint, with interposition of tendon in the defect to maintain radioulnar separation with favorable outcomes.^{10–13} DRUJA, the Sauvé-Kapandji procedure, has the benefit of maintaining ulnar support of the wrist while still allowing pronation and supination of the forearm therefore providing greater wrist stability than resection alone.¹² The distal ulnar resection is performed more proximal than the DUR and thus can increase the likelihood of convergence and impingement upon the radius, causing painful clicking with forearm rotation in up to 39% of patients.^{14–18} Implant arthroplasty is being utilized with increasing frequency to treat DRUJ arthritis, ranging from partial ulnar head replacement to total joint replacement, although these procedures are generally reserved for failed resection or arthrodesis procedures. Current studies suggest favorable outcomes with survivorship ranging from 93 to 97% at 4- to 5-year follow-up, however, complication rates have been reported to be as high as 28% and there is a paucity of literature determining long-term outcomes of implant arthroplasty.¹⁹

There are several limitations to this study. First, as a retrospective study reliant upon accurate documentation, there was no way to ensure the quality of the data being reported. Second, sample sizes of treatment groups were limited and likely underpowered to detect differences in certain outcomes. Third, we only compared differences in adverse outcomes and were unable to compare patient satisfaction through measures such as patient-reported outcomes. Lastly, while we attempted to control for confounding variables in our analysis, there are likely variables that we were unable to account for in analysis, such as the preoperative functional status or the functional demands of patients.

While DRUJ procedures are successful for the majority of patients, many continue to suffer from pain and limited ROM following their procedure, highlighting the need to explore more effective surgical options for treating DRUJ arthritis. Our data indicates that there is no one superior technique for treatment of DRUJ arthritis.

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Conflict of Interest

P.K.B. reports other from Cross Current Business Analytics, other from Dimension Orthotics LLC, other from Force Therapeutics, other from Journal of Hand Surgery, other from Matador, Inc, other from OBERD, personal fees from

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